REDUNDANTLY CONSTRAINED LAMINAR STRUCTURE AS WEAK-LINK MECHANISMS

This application claims the benefit of prior filed copending provisional application filed Oct. 11, 2000, by Deming Shu, Thomas S. Toellner, and Esen E. Alp, provisional application No. 60/239,599 and entitled REDUNDANTLY CONSTRAINED LAMINAR STRUCTURE AS WEAK-LINK MECHANISMS. The subject matter of the above-identified copending provisional application is incorporated herein by reference.

CONTRACTUAL ORIGIN OF THE INVENTION

The United States Government has rights in this invention pursuant to Contract No. W-31-109-ENG-38 between the United States Government and Argonne National Laboratory.

FIELD OF THE INVENTION

The present invention relates to a novel weak-link mechanism with redundant constrained structure, and more particularly, relates to redundantly constrained laminar structures as weak-link mechanisms and a novel method for manufacturing the redundantly constrained laminar structures as weak-link mechanisms.

DESCRIPTION OF THE RELATED ART

Known weak-link mechanisms typically are single layer structures with usually only two connections. Fabrication techniques for the structures involve precision machining of individual blocks of metal or other material. This is expensive and difficult to achieve the desired precision. These single layer structures do not normally have the desired stiffness against flexing. In addition, the limitation of two connecting links is a factor in the instability of the structure during the small movements.

It is desirable to provide weak-link mechanisms that allow very small, controllable movements in certain directions while exhibiting a high level of stiffness to resist distortion in another direction. Unlike the traditional kinematics linear spring mechanisms, redundant constrained weak-link mechanisms should provide much higher structure stiffness and stability. A need exists for weak-link mechanisms in various instruments involving small, controllable movements to provide high sensitivity while maintaining stability in the positioning of a device or devices, such as optical devices or other devices.

A principal object of the present invention is to provide a novel weak-link mechanism with redundant constrained structure.

Another of the present invention is to provide redundantly constrained laminar structures as weak-link mechanisms.

Another of the present invention is to provide redundantly constrained laminar structures as weak-link mechanisms allowing very small, controllable movements in certain directions while exhibiting a high level of stiffness to resist distortion in another direction.

Another of the present invention is to provide a novel method for manufacturing the redundantly constrained laminar structures as weak-link mechanisms.

Another of the present invention is to provide a novel method for manufacturing the redundantly constrained laminar structures as weak-link mechanisms by a relatively inexpensive and precise technique of producing multiple, substantially identical, thin layers of a design with the controllable movement being in the plane of the layer and stacking the substantially identical, thin layers to form a structure having the desired stiffness and stability.

Other important objects of the present invention are to provide such manufacturing method and redundantly constrained laminar structures as weak-link mechanisms substantially without negative effect and that overcome some disadvantages of prior art arrangements.

SUMMARY OF THE INVENTION

In brief, redundantly constrained laminar structures as weak-link mechanisms and a novel method for manufacturing the redundantly constrained laminar structures as weak-link mechanisms are provided. The method for producing the redundantly constrained laminar structures as weak-link mechanisms is carried out by lithographic techniques. A designed pattern is repeatedly chemically etched with a mask to produce a plurality of individual substantially identical units. The units are stacked together to form the laminar structure and are secured together. A high quality adhesive can be applied to the sides of the laminar structure to provide the mechanism equivalent to a single piece mechanism.

The redundantly constrained laminar structures as weak-link mechanisms of the invention include a stack of a plurality of thin material structures. The stack of structures forming a laminar structure include multiple weak-link connections providing controllable movements in a plane of the layer and having a desired stiffness and stability.

In accordance with features of the invention, the plurality of thin material structures include predetermined locating-holes used with locating-pins to precisely stack the thin material structures together and are used with fasteners to secure the stack together.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention together with the above and other objects and advantages may best be understood from the following detailed description of the preferred embodiments of the invention illustrated in the drawings, wherein:

FIG. **1** illustrates an exemplary redundantly constrained weak-link structure in accordance with the preferred embodiment;

FIG. **2** illustrates another exemplary redundantly constrained weak-link structure in accordance with the preferred embodiment;

FIGS. **3** and **4** illustrate an exemplary miniature multi-axis driving structure with a high-stiffness weak-link structure in accordance with the preferred embodiment; and

FIG. **5** is a flow chart illustrating exemplary steps for manufacturing the redundantly constrained laminar structures as weak-link mechanisms.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Having reference now to the drawings, in FIG. **1** there is shown an exemplary redundantly constrained weak-link structure in accordance with the preferred embodiment generally designated by the reference character **100**. FIG. **1** shows the shape of the metal weak-link sheet **102**, which is produced by a photochemical machining process. Two motion structures **104**, **106** are designed on the same metal sheet **102**. A wheel-shaped weak-link group **104** acts as a planar rotary shaft, and a parallelogram-shaped weak-link